

Claims

- [c1] 1. A system for controlling exhaust emission oxides of nitrogen (NO_x) during restarts of an internal combustion engine (ICE), the system comprising:
a first sensor for determining a first level of exhaust gas oxygen at a location upstream of a catalytic converter;
a second sensor for determining a second level of exhaust gas oxygen at a location mid-bed of the catalytic;
and
a controller for performing at least one process to reduce NO_x emissions when a difference between the first level of exhaust gas oxygen and the second level of exhaust gas oxygen exceeds a predetermined amount.
- [c2] 2. The system set forth in claim 1 wherein the at least one process to reduce NO_x emissions comprises delaying an engine restart for a predetermined time.
- [c3] 3. The system set forth in claim 1 wherein the at least one process to reduce NO_x emissions comprises limiting the number of restarts to a predetermined number during a selected interval of time.
- [c4] 4. The system set forth in claim 1 wherein the at least

one process to reduce NOx emissions comprises minimizing pumped oxygen.

- [c5] 5. The system set forth in claim 4 wherein minimizing pumped oxygen comprises closing a throttle during shutdown.
- [c6] 6. The system set forth in claim 1 wherein the at least one process to reduce NOx emissions comprises providing rich fueling during the engine restart condition to recondition the catalytic converter.
- [c7] 7. The system set forth in claim 1 wherein at least one of the first and second levels of exhaust gas oxygen are determined using a heated exhaust gas oxygen (HEGO) sensor.
- [c8] 8. The system set forth in claim 1 wherein at least one of the first and second levels of exhaust gas oxygen are determined using a universal exhaust gas oxygen (UEGO) sensor.
- [c9] 9. The system set forth in claim 1 wherein the catalytic converter is a three-way catalytic converter (TWC).
- [c10] 10. A system for controlling exhaust emission oxides of nitrogen (NOx) during restarts of an internal combustion engine (ICE), the system comprising:

a first sensor for determining a first level of exhaust gas oxygen at a location mid-bed of a catalytic converter;
a second sensor for determining a second level of exhaust gas oxygen at a location downstream of the catalytic converter; and
a controller for performing at least one process to reduce NOx emissions when a difference between the first level of exhaust gas oxygen and the second level of exhaust gas oxygen exceeds a predetermined amount.

[c11] 11. The system set forth in claim 10 wherein the at least one process to reduce NOx emissions comprises delaying an engine restart for a predetermined time.

[c12] 12. The system set forth in claim 10 wherein the at least one process to reduce NOx emissions comprises limiting the number of restarts to a predetermined number during a selected interval of time.

[c13] 13. The system set forth in claim 10 wherein the at least one process to reduce NOx emissions comprises minimizing pumped oxygen.

[c14] 14. The system set forth in claim 13 wherein minimizing pumped oxygen comprises closing a throttle during shutdown.

[c15] 15. The system set forth in claim 10 wherein the at least

one process to reduce NO_x emissions comprises providing rich fueling during the engine restart condition to recondition the catalytic converter.

[c16] 16. The system set forth in claim 10 wherein at least one of the first and second levels of exhaust gas oxygen are determined using a heated exhaust gas oxygen (HEGO) sensor.

[c17] 17. The system set forth in claim 10 wherein at least one of the first and second levels of exhaust gas oxygen are determined using a universal exhaust gas oxygen (UEGO) sensor.

[c18] 18. The system set forth in claim 10 wherein the catalytic converter is a three-way catalytic converter (TWC).

[c19] 19. A system for controlling exhaust emission oxides of nitrogen (NO_x) during restarts of an internal combustion engine (ICE), the system comprising:
a first sensor for determining a first level of exhaust gas oxygen a location upstream of a three-way catalytic converter (TWC);
a second sensor for determining a second level of exhaust gas oxygen at a location mid-bed of the TWC;
a third sensor for determining a third level of exhaust gas oxygen a location downstream of the TWC; and

a controller for dynamically monitoring the exhaust gas oxygen level at the locations in the exhaust system and performing at least one process to reduce NO_x emissions when a difference between the levels of exhaust gas oxygen exceeds a predetermined amount.

[c20] 20. The system set forth in claim 19 wherein the process to reduce NO_x emissions comprises at least one of delaying an engine restart for a predetermined time, limiting the number of restarts to a predetermined number during a selected interval of time, minimizing pumped oxygen, and providing rich fueling during the engine restart condition to recondition the catalytic converter.